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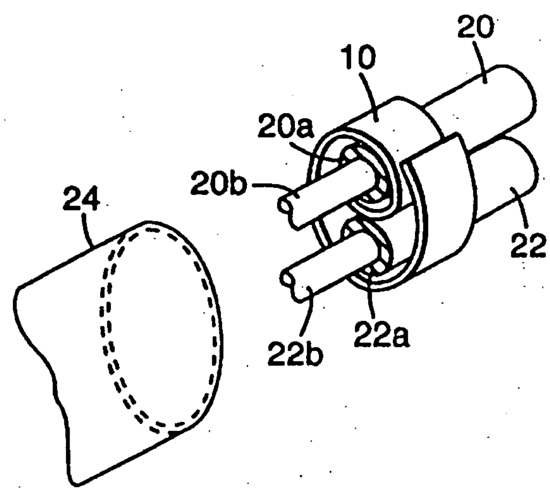
(54) Title: INSERT PARTS FOR SEALED CLOSURE BONDING

(57) Abstract

An insert part (10) seals cables (20, 22) of the type having low surface energy outer jackets. The insert part (10) includes a binder agent and susceptor material dispersed in the binder agent. The susceptor material generates heat when subjected to an electromagnetic field. The heat melts the binder agent, and the binder agent fuses with the low surface energy outer jackets of the cables (20, 22). Alternatively, the dual sheets of the binder agent may sandwich a resistive wire. The resistive wire generates heat when supplied with a current. The heat melts the binder agent and fuses it with the low surface energy outer jackets of the cables (20, 22). The binder agent may also fuse a housing (24), such as an elastomeric tube, with the binder agent and the outer jackets (20a, 22a) of the cables (20, 22).



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INSERT PARTS FOR SEALED CLOSURE BONDING

Background of the Invention

The present invention generally relates to bonding of sealed closures for protecting cables, such as communications and electronics cables, and, more particularly, to insert parts for bonding sealed closures with outer jackets of such cables to form protective barriers against environmental contact that could affect integrity of the cables.

Several sealed closures and methods for sealed closure have been employed to seal portions of cables, such as electronics and communications cables having conductor elements and a low surface energy outer jacket. Although the terms "conductor" and "conductor elements" are used herein, it is to be understood that the terms refer herein to not only electrical conductors, but also to any and all other materials and paths for communication, such as optical fibers and others. The low surface energy outer jacket of these cables, typically polyethylene, polypropylene, or an inclusive co-polymer, forms a protective sheath around the conductor elements. This low surface energy outer jacket serves as a barrier to contact of environmental conditions with the conductor elements. If the integrity of the outer jacket of these cables is compromised, however, for example, by removal of the outer jacket to access the conductor elements to splice or otherwise manipulate the conductor elements of the cable, by wear damage to the outer jacket, or by other conditions, the outer jacket does not sufficiently seal the conductor elements from the environment. As may be expected, the integrity of the cables, including their useful life expectancy, their strength, their operation, and their other characteristics, may be affected if the seal of the outer jacket is not repaired or replaced.

Closures of various types have been employed for such repair or replacement. These closures must be sealed with the low surface energy outer jacket of the cables to prevent environmental conditions from contacting and damaging the cables, particularly, the conductor elements of the cables. It is, thus, imperative and desirable to adequately sealingly enclose the conductor

elements of the cables to prevent contact with the environment, thereby protecting against environmental effects. As can be understood, sealed closures for cables have been particularly important in locations of cable splices where the outer jacket of the cable has been removed and in locations of deterioration or other damage to the outer jacket.

With conventional sealed closures for these purposes, an outer covering or housing has been placed over portions of the cable in locations of exposed conductor elements, such as at splices and deteriorated sections. The covering or housing has then been sealed with the remaining outer jacket of the cables to seal the conductor elements within the covering or housing. Typically, the covering or housing has been sealed with the outer jacket by pressure seal. The pressure seal is achieved by shrinking the covering or housing against the cable outer jacket and/or by expanding or adhering sealants or other materials between the covering or housing and the outer jacket.

Heating has sometimes been employed to shrink the covering or housing against the low surface energy outer jacket of the cable and/or to expand or adhere the sealants and other materials in voids between the covering or housing and the outer jacket. Several systems and methods of heating are conventional. For example, heating has typically been either by resistive, inductive, external torch, or chemical process. In resistive heating, wires of high resistance are located in the vicinity of the desired heating. Electrical current is fed to the wires, and the resistance of the wires generates heat. The current may be varied to obtain the desired heat. In induction heating, electromagnetic elements are placed in the vicinity of the desired heating and a magnetic field is oscillated around the electromagnetic elements. The electromagnetic elements in the magnetic field generate the heat. In chemical heating, reactive chemicals which generate a desirable heat of reaction are placed in desired locations for the heating. The reaction of the chemicals generates heat in those locations.

Conventional systems and methods of heat sealing closures have proven problematic. One problem has been that the heat sealing has merely created a pressure seal of the covering or housing against the low surface energy outer

jacket of the cable. This is because bonding, that is, fusion of materials, of the covering or housing to the outer jacket is difficult. Temperatures required to bond the outer jacket and covering or housing have not been easily achieved in the area of contact of the outer jacket and the covering or housing. In typical heating, heat is applied to the outer surface of the covering or housing, causing melting or shrinking of the covering or housing but not fusion of the covering or housing with the outer jacket. The resulting seal from such heating has been primarily merely a pressure seal.

Another problem with conventional systems and methods of heat sealing has been that sealants or other materials placed between the covering or housing and the outer jacket have not themselves fused with the covering or housing and the outer jacket. Instead, those sealants and materials have typically only expanded to fill voids or adhered to the surfaces of the covering or housing and the outer jacket. As can be appreciated, a fusing type of bonding would provide a more impenetrable seal in such instances.

Therefore, what is needed is insert parts for sealed bonding of closures, such as coverings or housings, with the low surface energy outer jacket of cables, which inserts avoid the problems of prior heated sealings and which provide advantages of impenetrable seals, stronger and more versatile seals, ease of use, low cost, field-use simplicity, and others.

Summary of the Invention

Embodiments of the present invention, accordingly, provide apparatus and methods for sealed bonding of cables using insert parts. The embodiments avoid problems of conventional heated sealings and provide advantages of virtually impenetrable seals, stronger and more versatile seals, ease of use, low cost, field-use simplicity, and other advantages.

To this end, one embodiment of the invention is an insert part for sealing cables of the type having low surface energy outer jackets. The insert part includes a flexible binder agent and susceptor material dispersed in the binder agent. The susceptor material generate heat when subjected to an electromagnetic field, the heat melts the flexible binder agent, and the flexible binder agent raises the surface temperature of the low surface energy jacket and

the binder fuses with the low surface energy outer jackets of the cables.

Another embodiment of the invention is a method for sealing cables of the type having low surface energy outer jackets. The method includes the steps of wrapping a flexible binder agent with dispersed susceptor material around and between the cables and subjecting the flexible binder agent with dispersed susceptor material to an electromagnetic field. The susceptor material generates heat when subjected to the electromagnetic field, the heat melts the flexible binder agent, and the flexible binder agent fuses with the low surface energy outer jackets of the cables.

Yet another embodiment of the invention is an insert part for sealing cables having low surface energy outer jackets. The insert part includes a three-pronged clip having a trench in the middle prong, a binder material contained in the trench, and susceptor material dispersed in the binder material. The susceptor material generates heat when subjected to an electromagnetic field, the heat melts the binder material and three-pronged clip, and the binder material and three-pronged clip fuse with the low surface energy outer jackets of the cables.

Another embodiment of the invention is a method for sealing cables of the type having low surface energy outer jackets. The method includes the steps of placing the cables through an elastomeric tube, placing substantially diametrically opposing sides of the elastomeric tube between a first and middle prong and between a middle and third prong, respectively, of a three-pronged clip having a trench in the middle prong filled with a binder material with dispersed susceptor material, and between the cables, and subjecting the binder material with dispersed susceptor material to an electromagnetic field. The susceptor material generates heat when subjected to the electromagnetic field, fusing the binder material, the three-pronged clip where adjacent the elastomeric tube and the cables, the elastomeric tube where adjacent the three-pronged clip, and the outer jackets of the cables in the vicinity of the three-pronged clip.

A further embodiment of the invention is an insert part for sealing cables of the type having low surface energy outer jackets. The insert part

includes a bondable sheet, a binder agent wrapped around the bondable sheet, and susceptor material dispersed within the binder agent. The susceptor material generates heat when subjected to an electromagnetic field, the heat melts the binder agent and the bondable sheet, and the binder agent and the bondable sheet fuse with the low surface energy outer jackets of the cables.

Another embodiment of the invention is a method for sealing cables of the type having low surface energy outer jackets. The method includes the steps of providing a bondable sheet, wrapping a binder agent around the bondable sheet, placing the bondable sheet wrapped with the binder agent between the cables, dispersing susceptor material within the binder agent, and subjecting the binder agent with dispersed susceptor material to an electromagnetic field. The susceptor material generates heat when subjected to the electromagnetic field, the heat melts the binder agent and the bondable sheet, and the binder agent and the bondable sheet fuse with the low surface energy outer jackets of the cables.

Yet another embodiment of the invention is an insert part for sealing cables of the type having low surface energy outer jackets. The insert part includes a bondable structure having four planar sheets extending from along a line, binder sheets affixed to each side of the four planar sheets, and susceptor material dispersed within said binder sheets. The susceptor material generates heat when subjected to an electromagnetic field, the heat melts the binder sheets and the bondable structure, and the bondable structure and the binder sheets fuse with the low surface energy outer jackets of the cables.

Another embodiment of the invention is a method for sealing cables of the type having low surface energy outer jackets. The method includes the steps of providing a bondable structure having four planar sheets extending from along a line, affixing binder sheets to each side of the four planar sheets, dispersing susceptor material within the binder sheets, and subjecting the binder sheets with dispersed susceptor material to an electromagnetic field. The susceptor material generates heat when subjected to the electromagnetic field, the heat melts the binder sheets and the bondable structure, and the bondable structure and the binder sheets fuse with the low surface energy outer jackets of

the cables.

Even another embodiment of the invention is an insert part for sealing cables of the type having low surface energy outer jackets. The insert part includes a first planar bondable sheet, a second planar bondable sheet, and first resistive wires sandwiched between the first and second planar bondable sheets. The first resistive wires, when supplied with current, fuse the first and second planar bondable sheets with the outer jackets of the cables.

Another embodiment of the invention is a method for sealing cables of the type having low surface energy outer jackets. The method includes the steps of sandwiching a first resistive wire between a first planar bondable sheet and a second planar bondable sheet and supplying a current to the first resistive wire. The step of supplying causes the first and second planar bondable sheets to fuse with the outer jackets of the cables.

Yet another embodiment of the invention is a flat ribbon for sealing cables of the type having low surface energy outer jackets, using a cylindrical solid having at least one longitudinal hole. The flat ribbon includes a lengthy section of substantially the circumference of the cylindrical solid and at least one smaller section, the number of smaller sections corresponding the number of holes, each of the smaller sections being laterally connected to the lengthy section. Each of the smaller sections is locatable in respective ones of the holes when the length section is located around the circumference of the cylindrical solid. Each of the cables is located within a respective hole with the respective smaller section encircling the respective cable.

Brief Description of the Drawings

Fig. 1 is a perspective view of an insert part for sealed bonding of the low surface energy outer jacket of cables, according to embodiments of the present invention, for example, for use in applications of a cable junction or branch-off.

Fig. 2 is a perspective view of a composite suitable as the insert part of Fig. 1, of a polyethylene film sandwiched between layers of a composite material, for induction bonding of sealed closures for cables, according to embodiments of the present invention

Fig. 3 is a flow diagram of a method for fusion bonding using the insert part of Fig. 1, comprised of the composite of Fig. 2, according to embodiments of the present invention.

Fig. 4 is a perspective view of an alternative clip insert part, utilizing a three pronged clip, for sealed bonding of the low surface energy outer jacket of cables, according to embodiments of the present invention, for example, for use in applications of a cable junction or branch-off.

Fig. 5 is a perspective view of the alternative clip insert part of Fig. 4 in use with a pre-stretched or shrinkable tube for sealed bonding, according to embodiments of the present invention.

Fig. 6 is a perspective, partial phantom view of the alternative clip insert part and the pre-stretched or shrinkable tube of Fig. 5 as employed in sealed bonding of cables, according to embodiments of the present invention.

Fig. 7 is a flow diagram of a method for fusion bonding using the alternative clip insert part of Fig. 4, for sealing the cables with the pre-stretched or shrinkable tube of Fig. 6, according to embodiments of the present invention.

Fig. 8 is a perspective view of another alternative insert part, utilizing polyethylene sheeting, for sealed bonding of the low surface energy outer jacket of cables, according to embodiments of the present invention, for example, for use in applications of a cable junction or branch-off or for use in applications of a reenterable dome base.

Fig. 9 is a flow diagram of a method for fusion bonding using the alternative insert part of Fig. 8, according to embodiments of the present invention.

Fig. 10 is a perspective view of the alternative insert part of Fig. 8, as used for sealed bonding of cables with a reenterable dome base, according to embodiments of the present invention.

Fig. 11 is an elevational, side view of cables sealed with a reenterable dome base and encased within a reenterable dome sealed with the base, according to embodiments of the present invention.

Fig. 12 is a perspective view of a structure for an alternative star insert

part for sealed bonding of the low surface energy outer jacket of cables, according to embodiments of the present invention, for example, for use in applications of sealing a reenterable dome base.

Fig. 13 is a perspective view of the structure of Fig. 12, as engaged for use as the alternative star insert part, according to embodiments of the present invention.

Fig. 14 is an end view of the alternative star insert part, formed by the structure of Fig. 13 with attached binder sheets on the faces of the structure, according to embodiments of the present invention.

Fig. 15 is an exploded, perspective view of a portion of the alternative star insert part, showing the structure sandwiched between dual binder sheets, according to embodiments of the present invention.

Fig. 16 is a perspective view of use of the alternative star insert part with four cables wrapped by a flexible film ribbon, according to embodiments of the present invention.

Fig. 17 is a perspective, partial phantom view of the alternative star insert part in use for bonding four cables within a housing.

Fig. 18 is a flow diagram of a method for fusion bonding using the alternative star insert part, according to embodiments of the present invention

Fig. 19 is an elevational, side view of four cables sealed with a reenterable dome base and encased within a reenterable dome sealed with the base, according to embodiments of the present invention.

Fig. 20 is a set of resistive binding inserts which are suitable in forming a star-shaped insert for sealed bonding of four cables within a housing, according to embodiments of the present invention.

Fig. 21 is an end view of the star-shaped insert of Fig. 20 for resistive bonding, showing additional elements of polyethylene rods inserted between the cables and the insert for added sealing, according to embodiments of the present invention.

Fig. 22 is a flat ribbon for inductive bonding of a cylindrical solid having three cable holes with a housing, according to embodiments of the present invention.

Figs. 23A-C are alternative flat ribbons for resistive bonding of cylindrical solids having three cable holes, two cable holes, or one cable hole, respectively, with a housing, according to embodiments of the present invention.

Detailed Description of the Preferred Embodiment

Referring to Fig. 1, the reference numeral 10 refers to an insert part for use in sealing cables 20 and 22, such as communications or electronics cables, at a cable junction or branch-off. The insert part 10 is a strip of pliable, bondable material. The insert part 10 is wrapped around and between the cables 20 and 22. The cables 20 and 22 are conventional, having low surface energy outer jackets 20a and 22a, respectively. The low energy outer jackets 20a and 22a of the cables 20 and 22, respectively, encase conductor elements 20b and 22b, respectively. As previously mentioned, although the terms "conductor" and "conductor elements" are used herein, it is to be understood that the terms refer herein to not only electrical conductors, but also to any and all materials and paths for communication, such as optical fibers and others.

The insert part 10, when heated and melted, causes fusion of the insert part 10 with the low surface energy outer jackets 20a and 22a of the cables 20 and 22, respectively. The bondable material comprising the insert part 10 may also, when heated and melted, cause fusion bonding of the insert part 10 and the outer jackets 20a and 22a with a housing 24 into which the insert part 10, as wrapped around and between the cables 20 and 22, is placed. A number of housings 24 are conventional, such as, for example, a pre-stretched shrinkable tube as disclosed in U.S. Patent No. 5,080,942 and U.S. Patent No. 4,389,440, each of the same assignee of the present invention and each incorporated herein by this reference, a reenterable dome base, such as that of the 3M Reenterable PST Dome closure available from the Minnesota Mining and Manufacturing Company, St. Paul, Minnesota ("3M") and other coverings or closures.

The bondable material comprising the insert part 10 is any of a variety of materials which may be sufficiently heated when positioned between the outer jackets 20a and 22a of the cables 20 and 22, respectively, and when

positioned between the outer jackets 20a and 22a and the housing 24. The outer jackets 20a and 22a are typically comprised of a polyethylene, polypropylene, or an inclusive copolymer and, in any event, serve as electrical and environmental condition insulators. The housing 24 if, for example, the shrinkable tube, is an elastomer, such as oil extended ethylene propylene diene monomers or ethylene propylene monomers (EPDM or EPM), or compounded rubbers or other elastomers, such as neoprene, butyl rubber elastomers, polypropylene/butyl rubber elastomers, polypropylene/EPDM elastomers, ethylene propylene copolymers, or other similar materials. The bondable material comprising the insert part 10, in every event, is heatable and meltable at temperatures sufficient to fuse the insert part 10 with the materials of the outer jackets 20a and 22a and the housing 24.

Referring to Fig. 2, one example of a bondable material suitable for the insert part 10 is a composite of a polyethylene film 30 tacked with dual layers of a composite material 32. The composite material 32 is for induction bonding (also referred to as "electromagnetic bonding") as disclosed in U.S. Patent Application Ser. No. 08/412,966, filed March 29, 1995, titled "Electromagnetic-Power-Absorbing Composite", assigned to the same assignee of the present invention and incorporated herein by this reference. That patent application discloses, among other things, an electromagnetic-power-absorbing composite comprising a plurality of multilayered flakes dispersed in a binder agent. The binder agent is any of a variety of suitable polymers or polymer blends, such as thermoplastic polymers, thermoplastic elastomers, and thermally activated or accelerated cure polymers, or a polymeric or nonpolymeric adhesive. The multilayered flakes may include at least one layer pair comprising one thin film crystalline ferromagnetic metal layer adjacent to one thin film dielectric layer. The multilayered flakes may be dispersed in the binder agent. In any event, the binder composition of the multilayered flakes dispersed in the binder agent is generally acted upon physically and/or chemically by heat generated within the composite due to the interaction of electromagnetic power with the multilayered flakes. The binder composition described is suitable as the composite material 32 and is tacked with the

polyethylene film 30 to form the insert part 10. The insert part 10 may be cut to desired size from a larger piece of the composite. Equipment for providing the electromagnetic power to perform induction bonding of the composite material 32 as previously mentioned is disclosed, for example, in U.S. Patent Application Ser. No. 08/413,119, filed March 19, 1995, titled "Induction Heating System for Fusion Bonding", assigned to the same assignee of the present invention and incorporated herein by this reference.

Referring to Fig. 3, in conjunction with Figs. 1 and 2, the reference numeral 40 refers, in general, to a method for fusion bonding using the insert part 10. In a step 42, the insert part 10 is wrapped around and between the cables 20 and 22. As so wrapped, the insert part 10 substantially entirely surrounds the low surface energy outer jackets 20a and 22a of the cables 20 and 22, respectively, over an about 0.5 to about 6 inch length of the cables 20 and 22 where the housing 24 is desired to be bonded to seal the cables 20 and 22. In a step 44, the insert part 10 is retained as wrapped, for example, by an elastomeric ring or tape. In a step 46, the insert part 10, as wrapped and retained, together with portions of the cables 20 and 22, is placed within an opening of the housing 24. If the housing is the shrinkable tube, previously described, the step 46 may include steps of preparing the shrinkable tube to accept the insert part 10 and cables 20 and 22. The steps may include, for example, stretching the tube and then shrinking the tube against the insert part 10. In a step 48, the insert part 10 is bonded with the outer jackets 20a and 22a and the housing 24. This bonding results in fusion of the materials of the insert part 10, the outer jackets 20a and 20b, and the housing 24.

An example of the method follows:

A flexible film member composed of low density polyethylene film (0.04 inch thickness, 2 inches by 5 inches) was sandwiched between two "susceptor composite binder strips" (0.015 inch thick, 2 inches by 5 inches low density polyethylene strips containing 5% "susceptor composite flakes" -J226-2 experimental production run) and tacked to the susceptor composite binder strips with a soldering iron. The composite of the flexible film member and susceptor composite binder strips was then used as an insert part placed in and

around two (2) twelve (12) inch lengths of fifty (50) pair twenty four (24) gauge telecommunication cables (SEAL PIC 5024) about 5 inches from one end of the cables laid side by side. A rubber band was used to hold the insert part in place as the other ends of the side-by-side cables were placed in one end of a seven (7) inch yellow polyethylene tube (pipe) (0.13 inch wall thickness, 1.40 inch inside diameter). A 3M Heat Shrink Modified Polychloroprene Tube (cut to about 5 inches long, size 2.0) was then shrunk down using a heat gun so that one end covered the insert part i.e., the composite wrapped between and around the cables (as shown in Fig. 1) and the other end up on the tube about 2 inches. A field from a radio frequency power source (power of about 75 to 85 watts at a frequency of 90 to 93 MHz) was used by placing the "tip antenna" over the heat shrink tubing above the "susceptor composite binder strip" in the insert part, causing it to melt and flow to bond the heat shrink tube to the cable jacket. After cooling, a second heat shrink tube equipped with an air fitting was placed over the open end of the tube and the tube pressurized at fifteen (15) pounds per square inch and submerged in a water tank for twenty four (24) hours without any leaks. Hand pressure could not separate the heat shrink tubing from the cable jacket. An air and water tight seal was thus formed, indicating that such a seal can be formed between a cable junction and a heat shrink closure.

Referring to Figs. 4-6, in conjunction, the reference numeral 50 refers to an alternative clip insert part for use in sealing cables 20 and 22 at a cable junction or branch-off within a housing 24, such as a pliable, shrinkable tube, for example, the shrinkable tube of the type previously described. The alternative clip insert part 50 is comprised of a three-pronged branch clip 52. The three-pronged branch clip 52 is generally conventional, being comprised of a connector 52a and three branches 52b, however, the middle branch 52b of the alternative clip insert part 50 includes a non-conventional trench 52c. The trench 52c is filled with a bondable material 54, for example, an adhesive containing electromagnetic-power-absorbing composite flakes, as previously described, that melts when heated to a temperature sufficient to also melt the middle branch 52b of the three-pronged branch clip 52.

The alternative clip insert part 50 is employed with the housing 24. The housing 24 is gathered and side-walls 24a of the housing 24 are placed between the outer branches 52b and the middle branch 52b, so that the housing 24 forms dual semi-cylindrical portions 24c. The middle branch 52b of the alternative clip insert part 50 includes the bondable material 54 within the trench 52c. The dual semi-cylindrical portions 24c each accommodate one of the cables 20 or 22. The bondable material 54, when heated and melted, bondingly fuses the bondable material 54, the middle branch 52b and other portions of the three-pronged branch clip 52 adjacent the middle branch 52b and the housing 24.

The bondable material 54 in the trench 52c of the three-pronged branch clip 52 is any of a variety of materials which is placeable in the trench 52 and which can be sufficiently heated when the middle branch 52c is disposed between the side-walls 24a of the housing 24. The bondable material 54 is, for example, a hot melt adhesive containing multilayered flakes that are electromagnetic-power-absorbing. These multilayered flakes are, as previously mentioned, disclosed in U.S. Patent Application Ser. No. 08/412,966. The hot melt adhesive has a melting point that is suitable to, at that melting point, fuse the hot melt adhesive, the three-pronged branch clip 52 adjacent the housing 24, and the housing 24 adjacent to the insert part 50. The semi-cylindrical portions 24c do not necessarily fuse with the low surface energy outer jackets (not identified by number in Fig. 6, but understood to be the surfaces of the cables 20 and 22 adjacent the side-walls 24a), however, the semi-cylindrical portions 24c of the housing 24 are shrunk against the cables 20 and 22, creating a pressure seal. Portions of the outer jackets of the cables 20 and 22 adjacent the alternative insert part 50 are fused with the alternative insert part 50 and the housing 24 in that vicinity. The bonding of the insert part 50, the outer jackets of the cables 20 and 22, and the housing 24, together with the shrinking of the semi-cylindrical portions 24c of the housing 24 against the cables 20 and 22, seals the housing 24 to the cables 20 and 22.

Referring to Fig. 7, the reference numeral 60 refers, in general, to a method for sealing the housing 24, the cables 20 and 22, and the alternative insert part 50, by the fusion bonding and the shrink pressurize seals. In a step

62, the trench 52c is created in the middle branch 52b of the three-pronged branch clip 52, for example, by boring, cutting, or molding. In a step 64, the trench 52c is filled with the bondable material 54, such as by pouring the bondable material 54 into the trench 52c and allowing the bondable material 54 to harden. In a step 66, the side-walls 24a of the housing 24 are gathered and inserted between the branches 52b of the insert part 50. The insert part 50, in a step 68, is heated to the melting point of the bondable material 54 to effect bonding of the bondable material 54, the three-pronged branch clip 52 adjacent the housing 24 and the bondable material 54, the housing 24 adjacent the insert part 50, and the outer jackets of the cables 20 and 22 adjacent the insert part 50 and the housing 24 in the vicinity of the of the insert part 50. In a step 70, the semi-cylindrical portions 24c of the housing 24 adjacent the outer jackets of the cables 20 and 22 are shrunk against the outer jackets, for example, by heat shrinking. The step 70 can be performed in conjunction with the step 68 if the bonding of step 68 occurs from heating of the bondable material 54 and the heating is sufficient to shrink the housing 24 against the outer jackets of the cables 20 and 22.

An example of the method 60 follows:

A "trench" was made in the middle leg of a three pronged branch clip made of Delrin (one-quarter-inch thickness, one and one eighth inches wide and two and one half inch long, with two outer prongs of one quarter inch width and an inner leg of three sixteenths width). A hot melt adhesive (Unirez 2291 polyamide from Union Camp) containing "susceptor composite flakes" was then melted into the trench (shown in figs. 4-6). A two (2) inch "susceptor composite binder strip" was tacked using a soldering iron on each of two (2) twelve (12) inch lengths of fifty (50) pair twenty four (24) gauge telecommunication cables (SEAL PIC 5024) about five (5) inches from one end. A two (2) inch length, one quarter inch wide polyethylene film (0.04 inch thickness) was also placed between the side-by-side cables. The other ends of the side-by-side cables were placed in one end of a seven (7) inch yellow polyethylene tube (pipe) (0.13 inch wall thickness, 1.04 inch inside diameter). The middle leg (containing the hot melt adhesive and susceptor composite

flakes) was thrust between the two polyethylene strips (thus also between the two cables with susceptor composite binder strips tacked on them), using the outer two legs (prongs) of the three pronged branch clip to hold a 3M Heat Shrink Modified Polychloroprene Tube (cut to about 5 inch long, size 1.5) as it was shrunk down using a heat gun so that one end covered the insert part (middle let of the three pronged branch clip) and cables and the other end extended up on the tube about 2 inches. A field from a radio frequency power source (94 MHz frequency) was used, as described in the immediately preceding example, to bond the heat shrink tube to the cable jacket. After cooling, it was observed that the heat had melted the polyethylene film, the hot melt adhesive, and the Delrin middle leg and the pressure from the heat shrink tube had caused the materials to flow to create the seal (the outer prongs of the three pronged insert remained intact). A second heat shrink tube equipped with an air fitting was placed over the open end of the tube and the tube pressurized at fifteen (15) pounds per square inch and submerged in a water tank for twenty four (24) hours. No leaks were detected. Hand pressure could not separate the heat shrink tubing from the cable jackets and the remaining insert part. Rubber tape can alternatively be used to hold the cables and the insert part together and to the splice closure, and electromagnetic bonding can be employed to form a permanent seal between the cable junction, the splice closure and the tape.

Referring to Fig. 8, the reference numeral 80 refers to another alternative insert part. The alternative insert part 80 includes a film sheet 82, a binder strip 84, and a bonding ribbon 84. The binder strip 84 is wrapped around the film sheet 82, and the binder strip 84 is fixed to the film sheet 82 as so wrapped, for example, by a soldering iron. The film sheet 82 is a substantially flat length, of width equal to about the sum of the diameters of the cables 20 and 22. The binder strip 84 is of a length and width sufficient to enwrap virtually the entire surface of the film sheet 82. The film sheet 82 and the binder strip 84, as tacked, is placed between the cables 20 and 22. The cables 20 and 22, in the same vicinity, are wrapped with the bonding ribbon 86, so that the cables 20 and 22 with the film sheet 82/binder strip 84 therebetween, are maintained within the circle of the bonding ribbon 86.

The insert part 80, when heated and melted, is fused with the low surface energy outer jackets 20a and 20b of the cables 20 and 22, respectively, sealing the cables 20 and 22 therebetween. The binder strip 84 and the bonding ribbon 86 are each comprised of bondable compositions, for example, the electromagnetic-power-absorbing composite disclosed in U.S. Patent Application Ser. No. 08/412,966 or some other bondable composition. A variety of materials that are meltable at bonding temperatures of the binder strip 84 and the bonding ribbon 86 and which, when melted, flow to seal voids may comprise the film sheet 82, such as, for example, low density polyethylene sheeting or film. In any event, the bondable composition is generally acted upon physically or chemically by heating in order to fuse the film sheet 82, the binder strip 84, the low surface energy outer jackets 20a and 20b, and the bonding ribbon 86.

Referring to Fig. 9, the reference numeral 90 refers, in general, to a method for sealing cables using the alternative insert part 80 of Fig. 8. In a step 92, the film sheet 82 is prepared by cutting it to a length and width sufficient for location between the cables 20 and 22 and which will provide the desired sealing along the length of the cables 20 and 22. In a step 94, the film sheet 82 is wrapped with the binder strip 84 to cover substantially the entire surfaces of the film sheet 82. The binder strip 84, as wrapped, is tacked with the film sheet 82, such as by a soldering iron, an adhesive, or some other tacker. In a step 96, the film sheet 82 and the binder strip 84, as tacked, are placed between the cables 20 and 22, so that the cables 20 and 22 contact the binder strip 84. In a step 98, the bonding ribbon 86 is wrapped around the cables 20 and 22 at the location of the film sheet 82 and binder strip 84, so that the bonding ribbon 86 contacts the cables 20 and 22. The bonding ribbon 86 is maintained so wrapped, for example, by an elastomeric ring, such as a rubber band, by an adhesive, or by tacking. In a step 100, the insert part 80, together with the film sheet 82, is bonded with the outer jackets 20a and 22a of the cables 20 and 22, respectively. This bonding results in fusion of the materials of the alternative insert part 80, including the film sheet 82, and the outer jackets 20a and 22a.

An example of the method 80 follows:

Two pieces (one-half inch wide and one inch long) of low density polyethylene film were wrapped in a "susceptor composite binder strip", and the binder strip and pieces of film were tacked together and placed as an insert part between two (2) twelve (12) inch lengths of fifty (50) pair twenty four (24) gauge telecommunication cables (SEAL PIC 5024) about one inch from the end. A "susceptor composite binder strip" was tacked around both cables and the insert part and wrapped tightly with a three-quarter inch wide rubber tape (3M LR Tape). A field from a radio frequency power source (101 MHz frequency) was used, as described in previous examples, to bond the rubber tape and the cable jackets each to the other. Hand pressure could not separate the cables, as bonded.

Referring to Fig. 10, the alternative insert part 80, previously described, is suitable for forming seals between multiple cables, for example, the cables 20 and 22, and a reenterable dome base 110. The reenterable dome base 110 is the base part of a 3M reenterable PST Dome closure. The reenterable dome base 110 is employed with the reenterable dome 112 which encases the cables 20 and 22. In sealing the cables 20 and 22 with the reenterable dome base 110, the alternative insert part 80 (shown in phantom) is placed between the cables 20 and 22, in the manner previously described. The cables 20 and 22 are wrapped with the bondable ribbon 86, also as previously described.

The cables 20 and 22, at the location of the alternative insert part 80, are disposed within a housing 111, for example, a shrinkable tube, as disclosed in U.S. Patent No. 5,080,942 and U.S. Patent No. 4,389,440, as previously mentioned. The housing 111 is shrunk or collapsed against the reenterable dome base 110, forming a neck 111a of the housing 111. The bonding ribbon 86 of the alternative insert part 80 contacts the neck 111a on the inner surface thereof. After the cables 20 and 22 and alternative insert part 80 are located in the neck 111a, the bonding step 100 is performed in the manner previously described. The bonding results in fusion of the neck 111a, the alternative insert part 80, and the low surface energy outer jackets 20a and 22a of the cables. The fusion seals the cables 20 and 22 with the housing 111.

Sealing of the cables 20 and 22 inside the neck 111a is possible by the method 90 of Fig. 9. The housing 111 is sealed with the reenterable dome base 110 by an additional step of inserting the housing 111 over the reenterable dome base 110, for example, by stretching the housing 111 and then shrinking the housing 111 against the reenterable dome base 110 in a conventional manner, such as by ties 114.

Referring to Fig. 11, the reenterable dome base 110, as so sealed, is equipped with the reenterable dome 112 in conventional manner. Also, in conventional manner, the reenterable dome 112 is maintained in place with the reenterable dome base 110. The reenterable dome 112 houses the cables 20 and 22, for example, at a splice or junction. Because the cables 20 and 22 are sealed with the reenterable dome base 110 through the housing 111, the reenterable dome 112 sealed with the reenterable dome base 110 provides environmental sealing of the cables 20 and 22 within the reenterable dome 112.

An example of a method of sealing cables with a reenterable dome base follows:

A flexible film member comprised of low density polyethylene film (0.04 inch thickness, two inches by 24 inches was sandwiched between two "susceptor composite binder strips" (0.015 inch thick low density polyethylene strip two inches by 24 inches - containing 5% "susceptor composite flakes" - J226-2 experimental production run) and the sandwich was tacked together with a soldering gun. A ½ inch strip was cut from the flexible film member and used as an insert part by placing it between two eighteen inch lengths of 50 pair 24 gauge telecommunication cables (SEAL PIC 5029) about 8 inches from one end. The remaining flexible film member was wrapped around the two cables and held in place with a rubber band. Both cable, side-by-side, having the two inch wide flexible member wrapped around the cables and the sandwich of polyethylene film and binder strips between the cables, were placed inside a 3M 4604 Reenterable PST Dome base. The short end of the cables was inserted through the Reenterable Dome base, so that the two inch flexible film member was outside the lower end of the base. Then a 3M 4604 Pull-N-Shrink Tube (PST - prestretched tube) was held over the lower end of the base and the core

unwound, allowing the PST tube to shrink down firmly around the base and the two inch flexible film member wrapped between and around the cables.

A field from a radio frequency power source (power of about 100 watts at frequency of 85.3 MHz) was used by placing the "tip" over the PST around the 2 inch flexible film member strip causing the flexible film member to melt, and allowing the PST to contract. The contracting of the PST forcing the melted flexible film member and insert part between and around the cables, which, when cooled, bonded the elastomeric PST material to the cable insulation. After cooling, the Reenterable Dome was attached to the base and heat shrink sleeves placed over each end of the extending cables, with one sleeve equipped with an air fitting. The Reenterable Dome was then pressurized with 4 pounds per square inch and placed in a water tank. The dome remained under pressure for seven (7) days without any leaks. Hand pressure could not remove the PST from the sealed cables.

Referring to Fig. 12, the reference numeral 120 refers to a structure for use as part of another alternative star insert part 122 (shown in Fig. 14) for use in sealing four cables. The structure 120 is formed of two identical flexible film members 124. The flexible film members 124 are each generally rectangular and each have a cut-out 126. The cut-out 126 extends about half the length of the flexible film member 124 and is slightly greater in width than the thickness of the flexible film member 124. The flexible film member 124 is a sufficiently rigid material for insertion between cables and is bondable, upon melting, with the low surface energy outer jackets of those cables, for example, low density polyethylene is suitable material for the flexible film member 124.

Referring to Fig. 13, the structure 120 is formed by engaging the cut-out 126 of each flexible film member 124 with that of the other.

Referring to Fig. 14, the alternative star insert part 122 includes the structure 120 and binder sheets 128 attached to each side of the structure 120. The binder sheets 128 are bondable materials that have a bonding temperature that is higher than the melting point of the materials of the flexible film member 124. For example, a suitable bondable material for the binder sheets 128 is the bondable material disclosed in U.S. Patent Application Ser. No.

08/412,966 previously mentioned. The binder sheets 128 are tacked to the flexible film members 124 of the structure 120, for example, by a soldering iron, an adhesive, or some other tacker.

Referring to Fig. 15, an enlarged, exploded view of the structure 120 where the binder sheets 128 are attached shows the flexible film member 124 sandwiched between the binder sheets 128.

Referring to Fig. 16, the alternative star insert part 122 is used in sealing four cables 20, 22, 130, and 132. The cables 20, 22, 130, and 132 are bunched and bound by a flexible film ribbon 134, for example, a low density polyethylene material, that is wound around the cables 20, 22, 130, and 132. The alternative star insert part 122 is forced into a space 136 between the cables 20, 22, 130, and 132, so that the part 122 contacts the low surface energy outer jackets (not shown in detail) of the cables 20, 22, 130, and 132 surrounding the space 136. The alternative star insert part 122, when heated by virtue of the binder sheets 128 and melted, is fused with the low surface energy outer jackets of the cables 20, 22, 130, and 132. This bonding seals the cables 20, 22, 130, and 132 each with the other.

Referring to Fig. 17, the alternative star insert part 122 is used to bond the low surface energy outer jackets (not shown in detail) of four cables 20, 22, 130, and 132 with a housing 138, for example, a shrinkable tube or rigid housing of the types previously mentioned. In this case, the cables are encircled by a binder ribbon 86, like that described above with respect to Fig. 8.

Referring to Fig. 18, the alternative star insert part 122 is employed in a method 140 to bondingly seal the cables 20, 22, 130, and 132 with the housing 138, such as a shrinkable tube. In a step 142, the structure 120 is formed, first, by cutting the flexible film members 124 and, second, by connecting the cut-outs 126 of the flexible film members 124. In a step 144, the binder sheets 128 are tacked to the faces of the flexible film members 124, for example, by soldering or adhesives. In a step 146, the alternative star insert part 122 is placed between the cables 20, 22, 130, and 132, as bunched. In a step 148, the binder ribbon 86 is wrapped around the cables 20, 22, 130, and 132 at the

insert part 122 and retained as wrapped, for example, by an elastomeric ring or by adhesive.

In a step 150, the cables 20, 22, 130, and 132 are inserted through the housing 138, so that the binder ribbon 86, the alternative star insert part 122, and the cables 20, 22, 130, and 132 are encircled by the housing 138. In a step 152, the housing 138 is shrunk or otherwise collapsed against the cables 20, 22, 130, and 132 at the insert part 122. In a step 154, the binder sheets 128 of the insert part 122 and the bonder ribbon 86 are heated and melted to fusingly bond with the low surface energy outer jackets (not shown in detail) of the cables 20, 22, 130, and 132 and the housing 138.

Referring to Fig. 19, the method 140 is employed, for example, to bondingly seal the cables 20, 22, 130, and 132 with the housing 111. The housing 111 is sealed with the reenterable dome base 110, and the reenterable dome base 110 is equipped with the reenterable dome 112 to sealingly enclose the cables 20, 22, 130, and 132

An example of the method 140 follows:

Two flexible film members, each composed of nine layers of low density polyethylene film (0.04 inch thickness), were tacked. Cut-out slots were formed in each member. A star insert part was prepared by inserting the two flexible film members, together, through the slots and a one-half inch wide strip of "susceptor composite binder strip" was tacked onto each leg of the star insert part. A second flexible film member was prepared as a ribbon. The star insert part was placed between four telecommunication cables, and the second flexible film member was wound around the cables. The four cables, having the star insert part between the cables and the second flexible film member wrapped around the cables, was installed in a 3M 4604 Reenterable PST Dome base and a 3M Pull-N-Shrink PST tube. A field from a radio frequency power source (88 MHz frequency) was passed over the insert part and the materials were bonded creating a seal.

Pressure testing was performed as in the prior example. The dome remained under pressure for seven (7) days at four (4) PSI without any leaks. Hand pressure could not remove the PST from the sealed cables.

Referring to Fig. 20, a set 160 of resistive binding inserts -- i.e., a resistive star insert 162 and a resistive binder ribbon 164 -- corresponding to the alternative star insert part 122 of Figs. 12-17 and the binder ribbon 86 of Fig. 17, respectively, is shown. The resistive star insert 162 is formed as previously described by engaging the slots 162a. The resistive star insert 162 is inserted between four cables, as previously described with respect to the alternative star insert part 122, and the resistive binder ribbon 164 is wrapped around the cables, as previously described with respect to the binder ribbon 86. Sealing of the cables, for example, with a housing, is achieved by the method 140 of Fig. 18, with the exception that the bonding occurs by resistive heating of the set 160 by supplying resistive current to wires 166 placed between layers of bondable material, such as polyethylene or polyethylene elastomer sheets.

An example of use of the set 160 follows:

A supporting pipe assembly was prepared using a six (6) inch supporting pipe (one-inch outside diameter, one-eighth inch wall thickness) with two (2) inch 3M 4628 Pull-N-Shrink Tubing over each end of the supporting pipe. Dow Engage 8400 (available from The Dow Chemical Company, Midland, Michigan) was used as the sealing material and was prepared as follows: A film of Engage (approximately 3 inches by 4 inches with a thickness of .1175 inch) was heat-pressed to a thickness of .1050 inch using a metal mold of the same thickness. Next, nichrome 80 wire ribbon (Pelican Wire Company) .125 inch wide and .005 inch thick was soldered onto the Engage material in a rectangular block pattern fitting inside a two inch by one inch border. Next, an Engage piece of identical size was placed over this piece and the two were heat pressed to a thickness of .1050 inch. The material was then allowed to cool and was trimmed to a final size of 2.25 inches by 1.25 inches. This process was repeated and the two Engage pieces were fitted inside the pipe on both ends.

Separately, two six (6) inch sections of three (3) pair twenty-two gauge telecommunication cable (Superior 3x22) were held together with a 3M 4464 Shield Bond connector in a butt configuration (cables aligned with their ends side-by-side in the same direction) with one wire pulled from one of the cables

to allow for pressurized air to enter later for testing purposes. A flexible film member insert composed of low density polyethylene film (.03125 inch thickness, one-half inch wide) was wrapped around the cables and pushed up into one end of the pipe assembly. The supporting pipe assembly was then bonded to the two cables (and the flexible film member insert) by using a power source to heat the nichrome ribbon. This heat caused the polyethylene to soften and flow around the cables. In addition, the pipe end was softened, allowing the pressure of the PST to cause contraction of the supporting pipe around the cables, forming a sealing bond.

The open end of the pipe was then closed off by the insertion of a hot melt adhesive plug (3M Jet-melt 3748 TC). the plug was positioned in a manner so that there was a slight gap between the end of the pipe and the end of the plug. Again, the Nichrome ribbon was heated, causing contraction of the pipe due to the applied pressure of the PST, and a seal was formed. The central position of the supporting pipe assembly did not soften and served as a protective closure over the cables.

After cooling, heat shrink sleeves were fitted over each end of the cables, with one sleeve equipped with an air valve, which was placed over the cable with the wire removed. The cable was pressurized with four (4) pounds per square inch and placed inside a water tank for three (3) days. The pressure was then increased to fifteen (15) PSI for twenty-four (24) hours without any leaks.

Another example of use of the set 160 follows:

Two complementary flexible film members composed of Dow Engage 7090329-2 were prepared as follows: A film of Engage (2.25 inch by 1.75 inch with a thickness of .1175 inch) was heat-pressed to a thickness of .1050 inch using a metal mold of the same thickness. This film was then trimmed to a size of 2.0 inches by 1.5 inches. Next, nichrome 80 wire ribbon .125 inch wide and .005 inch thick (Pelican Wire Company) was soldered onto this film of Engage in two different patterns. Engage pieces of identical sizes were placed over these two pieces and were heat-pressed to a final thickness of .1450 inch. The pieces were allowed to cool and cut-out slits were cut in each. A third

piece of Engage (having final dimensions of 5.75 inches by 1.0 inch with a thickness of .1450 inch) was prepared in a similar fashion, except that the wire ribbon was soldered in a rectangular block pattern.

Separately, four cables (50 pair 24 gauge SEALPIC 5024 telecommunication cables) were fitted with heat shrink sleeves with one of the sleeves equipped with an air valve. One wire was removed from the cable with the sleeve equipped with the air valve for later pressurizing purposes.

A star insert part was prepared by inserting the two complementary pieces of Engage together through the slots. The star insert part was placed between the four telecommunication cables and the third Engage film member wound around the cables. Four one (1) inch long low density polyethylene rods were then positioned between the cables and the star insert. The four cables having the star insert part and the Engage film member wrapped around the cables were installed in a 3M 4604 Reenterable Dome base and a 3M Pull-N-Shrink tube. The wire leads on the two pieces of the star insert were connected in series and then energized with a power source, causing the Engage material and the polyethylene plugs to soften, thereby creating a seal in the middle of the bundle of cables. The Engage piece wrapped around the cables was then heated, and a seal was created between the cables and the PST.

Referring to Fig. 21, in addition to the resistive star insert 162 of Fig. 20 for resistive bonding of four cables 20, 22, 130 and 132, polyethylene rods 164 are alternatively inserted between the cables 20, 22, 130, and 132 and the insert 162. The polyethylene rods 164 provide added sealing from bonding.

Referring to Fig. 22, a flat ribbon 170 is used for inductive bonding of a cylindrical solid having three cable holes (not shown). The flat ribbon is a composite material, such as the electromagnetic-power-absorbing composite disclosed in U.S. Patent Application Ser. No. 08/4121, 966, sandwiched between two bondable sheets, such as low density polyethylene film. The flat ribbon 170 includes a lengthy section 170a and three smaller sections 170b. The lengthy section 170a is sufficiently long to be wrapped around the circumference of the cylindrical solid. Each of the smaller sections 170b is sufficiently long to be placed around the internal circumference of respective

ones of the holes in the cylindrical solid. Cables are fed through the smaller sections 170b around the holes. The longer section 170a is either tacked to the cylindrical solid or tacked to the internal circumference of a housing, for example, a pre-stretched, shrinkable tube or some other covering, into which the cylindrical solid fits. Via electromagnetic bonding, as has been described herein, the cylindrical solid is sealed with the cables and with the housing, forming a sealed closure.

Figs. 23A-C are alternative flat ribbons 180a, 180b, and r180c, respectively, for resistive bonding of cylindrical solids having three cable holes, two cable holes, or one cable hole, respectively, with cables and a housing. Each of the alternative flat ribbons 180a, 180b, and 180c includes a high resistance wire 182 placed between dual bondable material sheets, such as low density polyethylene films. As those skilled in the art will understand and appreciate, the alternative flat ribbons 180a, 180b, and 180c are employed in substantially the same manner as the flat ribbon 170, however, bonding is by resistive heating upon supply of current to the high resistance wires 182.

Although illustrative embodiments of the invention have been shown and described, a wide range of modification, change, and substitution is contemplated in the foregoing disclosure and, in some instances, some features of the present invention may be employed without a corresponding use of the other features. Accordingly, it is appropriate that the appended claims be construed broadly and in a manner consistent with the scope of the invention.

What is Claimed is:

1. An insert part for sealing cables of the type having low surface energy outer jackets, comprising:

a flexible binder agent; and

susceptor material dispersed in the binder agent;

wherein the susceptor material generates heat when subjected to an electromagnetic field, the heat melts the flexible binder agent, and the flexible binder agent fuses with the low surface energy outer jackets of the cables.

2. The insert part of claim 1, wherein the flexible binder agent with dispersed susceptor material is wrapped around and between the cables.

3. The insert part of claim 1, further comprising dual bondable films between which the flexible binder agent with dispersed susceptor material is sandwiched.

4. The insert part of claim 1, wherein the flexible binder agent with dispersed susceptor material also fuses a housing with the flexible binder agent and the low surface energy outer jackets of the cables.

5. The insert part of claim 4, wherein the housing is a shrinkable elastomeric tube.

6. A method for sealing cables of the type having low surface energy outer jackets, comprising the steps of

wrapping a flexible binder agent with dispersed susceptor material around and between the cables; and

subjecting the flexible binder agent with dispersed susceptor material to an electromagnetic field;

wherein the susceptor material generates heat when subjected to the electromagnetic field, the heat melts the flexible binder agent, and

the flexible binder agent fuses with the low surface energy outer jackets of the cables.

7. The method of claim 6, further comprising the steps of:

sandwiching the flexible binder agent between bondable sheets;

wherein the step of wrapping includes wrapping the bondable sheets with the flexible binder agent and the step of subjecting causes fusing of the bondable sheets with the flexible binder agent and the low surface energy outer jackets of the cables.

8. The method of claim 7, further comprising the step of:

locating the cables, as wrapped with the flexible binder agent and the bondable sheets, within a housing;

wherein the step of subjecting causes fusing of the bondable sheets, the flexible binder agent, the housing, and the low surface energy outer jackets of the cables.

9. The product sealed cables of the method of claim 6.

10. The product sealed cables of the method of claim 7.

11. The product sealed cables of the method of claim 8.

12. An insert part for sealing cables of the having low surface energy outer jackets, comprising:

a three-pronged clip having a trench in the middle prong; and

a binder material contained in the trench; and

susceptor material dispersed in the binder material;

wherein the susceptor material generates heat when subjected to an electromagnetic field, the heat melts the binder material and three-pronged clip, and the binder material and three-pronged clip fuse with the low surface energy outer jackets of the cables.

13. The insert part of claim 12, wherein the three-pronged clip is located between the cables.

14. The insert part of claim 12, wherein the three-pronged clip retains diametrically opposing sides of an elastomeric tube between the first and middle prongs and the middle and third prongs, respectively, and wherein the elastomeric tube adjacent the three-pronged clip also fuses with the binder material, the three-pronged clip, and the outer jackets of the cables.

15. A method for sealing cables of the type having low surface energy outer jackets, comprising the steps of:

placing the cables through an elastomeric tube;

placing substantially diametrically opposing sides of the elastomeric tube between a first and middle prong and between a middle and third prong, respectively, of a three-pronged clip having a trench in the middle prong filled with a binder material with dispersed susceptor material, and between the cables;

subjecting the binder material with dispersed susceptor material to an electromagnetic field;

wherein the susceptor material generates heat when subjected to the electromagnetic field, fusing the binder material, the three-pronged clip where adjacent the elastomeric tube and the cables, the elastomeric tube where adjacent the three-pronged clip, and the outer jackets of the cables in the vicinity of the three-pronged clip.

16. The method of claim 15, further comprising the step of shrinking the elastomeric tube against the outer jackets of the cables.

17. The product sealed cables of the method of claim 16.

18. An insert part for sealing cables of the type having low surface

energy outer jackets, comprising:

a bondable sheet;

a binder agent wrapped around the bondable sheet; and

susceptor material dispersed within the binder agent;

wherein the susceptor material generates heat when subjected to an electromagnetic field, the heat melts the binder agent and the bondable sheet, and the binder agent and the bondable sheet fuse with the low surface energy outer jackets of the cables.

19. The insert part of claim 18, further comprising:

a binder strip wrapped around the cables; and

susceptor material dispersed within the binder strip;

wherein the susceptor material dispersed within the binder strip also generates heat when subjected to an electromagnetic field, the heat melts the binder strip, and the binder strip fuses with the low surface energy outer jackets of the cables, the binder agent, and the bondable sheet.

20. The insert part of claim 19, wherein the binder agent with dispersed susceptor material and the binder strip with dispersed susceptor material fuses a housing with the bondable sheet, the binder agent, the binder strip, and the low surface energy outer jackets of the cables.

21. The insert part of claim 20, wherein the housing is an elastomeric tube.

22. The insert part of claim 21, wherein the elastomeric tube is sealed with a reenterable dome base.

23. A method for sealing cables of the type having low surface energy outer jackets, comprising the steps of:

providing a bondable sheet;

wrapping a binder agent around the bondable sheet;

placing the bondable sheet wrapped with the binder agent between the cables;

dispersing susceptor material within the binder agent; and

subjecting the binder agent with dispersed susceptor material to an electromagnetic field;

wherein the susceptor material generates heat when subjected to the electromagnetic field, the heat melts the binder agent and the bondable sheet, and the binder agent and the bondable sheet fuse with the low surface energy outer jackets of the cables.

24. The insert part of claim 23, further comprising the steps of:

wrapping a binder strip around the cables;

dispersing susceptor material within the binder strip; and

subjecting the binder strip with dispersed metal flakes to an electromagnetic field;

wherein the susceptor material dispersed within the binder strip also generates heat when subjected to the electromagnetic field, the heat melts the binder strip, and the binder strip fuses with the low surface energy outer jackets of the cables, the binder agent, and the bondable sheet.

25. The method of claim 24, further comprising the step of:

placing the cables through a housing;

wherein the steps of subjecting fuse the binder agent, the bondable sheet, the low surface energy outer jackets of the cables, the binder strip, and the housing.

26. The method of claim 25, wherein the housing is an elastomeric tube.

27. The method of claim 26, wherein the elastomeric tube is sealed

with a reenterable dome base.

28. An insert part for sealing cables of the type having low surface energy outer jackets, comprising:

a bondable structure having four planar sheets extending from along a line;

binder sheets affixed to each side of the four planar sheets; and

susceptor material dispersed within said binder sheets;

wherein the susceptor material generates heat when subjected to an electromagnetic field, the heat melts the binder sheets and the bondable structure, and the bondable structure and the binder sheets fuse with the low surface energy outer jackets of the cables.

29. The insert part of claim 28, wherein the bondable structure comprises dual flat pieces, each having a slit, the slits being joined to yield the four planar sheets extending from along the line.

30. The insert part of claim 28, wherein each of four cables is located between adjacent planar sheets.

31. The insert part of claim 28, further comprising:

a flexible film ribbon wrapped around the cables in the vicinity of the binder sheets;

wherein the flexible film ribbon is heated and melted by the susceptor material when in the presence of a magnetic field, thereby fusing with the outer jackets of the cables, the binder sheets, and the bondable structure.

32. The insert part of claim 31, wherein the flexible film ribbon, the outer jackets, the binder sheets, and the bondable structure fuse with a housing.

33. The insert part of claim 32, wherein the flexible film ribbon

comprises a binder strip having susceptor material dispersed therein.

34. The insert part of claim 32, wherein the housing is an elastomeric shrinkable tube.

35. The insert part of claim 33, wherein the housing is an elastomeric shrinkable tube.

36. The insert part of claim 34, wherein the elastomeric shrinkable tube is sealed with a reenterable dome base.

37. The insert part of claim 35, wherein the elastomeric shrinkable tube is sealed with a reenterable dome base.

38. A method for sealing cables of the type having low surface energy outer jackets, comprising the steps of:

providing a bondable structure having four planar sheets extending from along a line;

affixing binder sheets to each side of the four planar sheets;

dispersing susceptor material within the binder sheets; and

subjecting the binder sheets with dispersed susceptor material to an electromagnetic field;

wherein the susceptor material generates heat when subjected to the electromagnetic field, the heat melts the binder sheets and the bondable structure, and the bondable structure and the binder sheets fuse with the low surface energy outer jackets of the cables.

39. The method of claim 38, wherein the bondable structure comprises dual flat pieces, each having a slit, the slits being joined to yield the four planar sheets extending from along the line.

40. The method of claim 38, further comprising the step of locating

each of four cables between respective ones of the adjacent planar sheets.

41. The method of claim 38, further comprising:

wrapping a flexible film ribbon around the cables in the vicinity of the binder sheets;

wherein the step of subjecting heats and melts the flexible film ribbon, thereby fusing the flexible film ribbon, the outer jackets of the cables, the binder sheets, and the bondable structure.

42. The method of claim 38, further comprising the step of:

placing the cables through a housing;

wherein the step of subjecting fuses the flexible film ribbon, the outer jackets, the binder sheets, and the bondable structure.

43. The method of claim 42, wherein the flexible film ribbon comprises a binder strip with susceptor material dispersed therein.

44. The method of claim 42, wherein the housing is an elastomeric shrinkable tube.

45. The method of claim 43, wherein the housing is an elastomeric shrinkable tube.

46. The method of claim 44, further comprising the step of sealing the elastomeric shrinkable tube with a reenterable dome base.

47. The method of claim 45, further comprising the step of sealing the elastomeric shrinkable tube with a reenterable dome base.

48. An insert part for sealing cables of the type having low surface energy outer jackets, comprising:

a first planar bondable sheet;

a second planar bondable sheet; and

first resistive wires sandwiched between the first and second planar bondable sheets;

wherein the first resistive wires, when supplied with current, fuse the first and second planar bondable sheets with the outer jackets of the cables.

49. The insert part of claim 48, further comprising:

a third planar bondable sheet;

a fourth planar bondable sheet; and

second resistive wires sandwiched between the third and fourth planar bondable sheets;

wherein the second resistive wires, when supplied with current, fuse the third and fourth planar bondable sheets with the outer jackets of the cables.

50. The insert part of claim 49, wherein the first and second planar bondable sheets and the third and fourth planar bondable sheets are engaged by slits in the sheets.

51. The insert part of claim 50, further comprising bondable rods adjacent the bondable sheets.

52. The insert part of claim 48, further comprising:

a first binder ribbon sheet;

a second binder ribbon sheet; and

resistive wires sandwiched between the first and second binder ribbon sheets;

wherein the resistive wires, when supplied with current, fuse the first and second binder ribbon sheets with the outer jackets of the cables.

53. The insert part of claim 50, further comprising bondable rods

adjacent the bondable sheets.

54. An method for sealing cables of the type having low surface energy outer jackets, comprising the steps of:

sandwiching a first resistive wire between a first planar bondable sheet and a second planar bondable sheet; and

supplying a current to the first resistive wire;

wherein the step of supplying causes the first and second planar bondable sheets to fuse with the outer jackets of the cables.

55. The method of claim 54, further comprising the steps of:

sandwiching a second resistive wire between a third planar bondable sheet and a fourth planar bondable sheet; and

supplying a current to the second resistive wire;

wherein the step of supplying causes the third and fourth planar bondable sheets to fuse with the outer jackets of the cables.

56. The method of claim 55, further comprising the step of engaging slits in the sheets.

57. The method of claim 56, further comprising the steps of:

sandwiching a resistive wire between a first binder ribbon sheet and a second binder ribbon sheet; and

supplying a current to the resistive wire;

wherein the step of supplying causes the first and second binder ribbon sheets to fuse with the outer jackets of the cables.

58. A flat ribbon for sealing cables of the type having low surface energy outer jackets, using a cylindrical solid having at least one longitudinal hole, comprising:

a lengthy section of substantially the circumference of the cylindrical solid; and

at least one smaller section, the number of smaller sections corresponding the number of holes, each of the smaller sections being laterally connected to the lengthy section;

wherein each of the smaller sections is locatable in respective ones of the holes when the length section is located around the circumference of the cylindrical solid; and

wherein each of the cables is located within a respective hole with the respective smaller section encircling the respective cable.

59. The flat ribbon of claim 58, wherein the flat ribbon is fused with the cylindrical solid and the cables by induction bonding.

60. The flat ribbon of claim 58, wherein the flat ribbon is fused with the cylindrical solid and the cables by resistive heating.

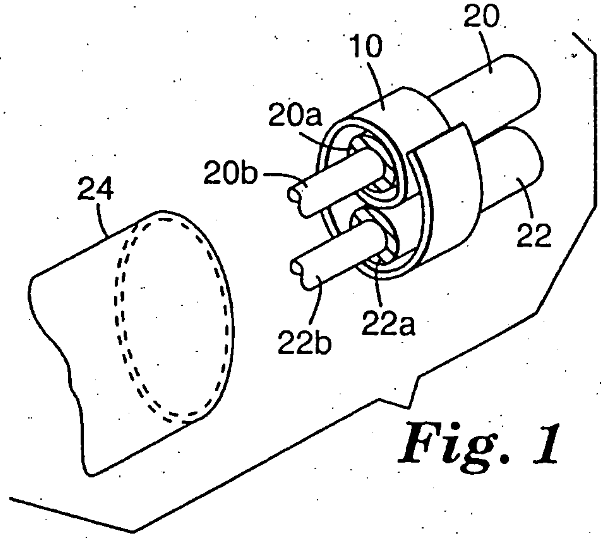


Fig. 1

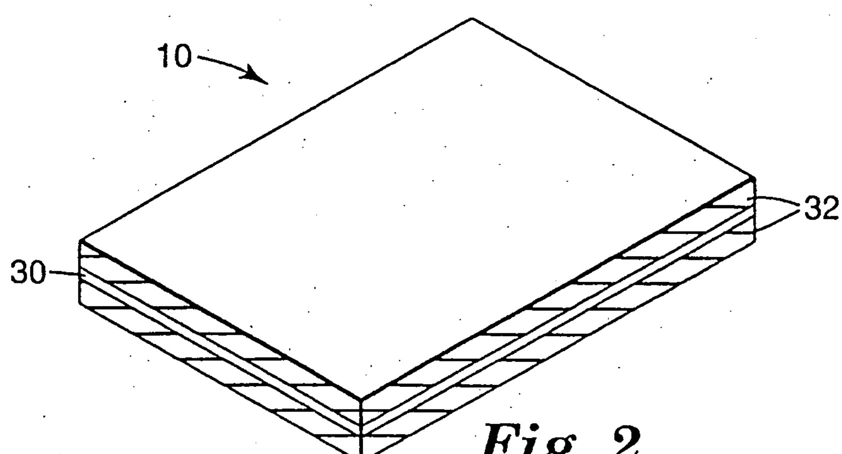


Fig. 2

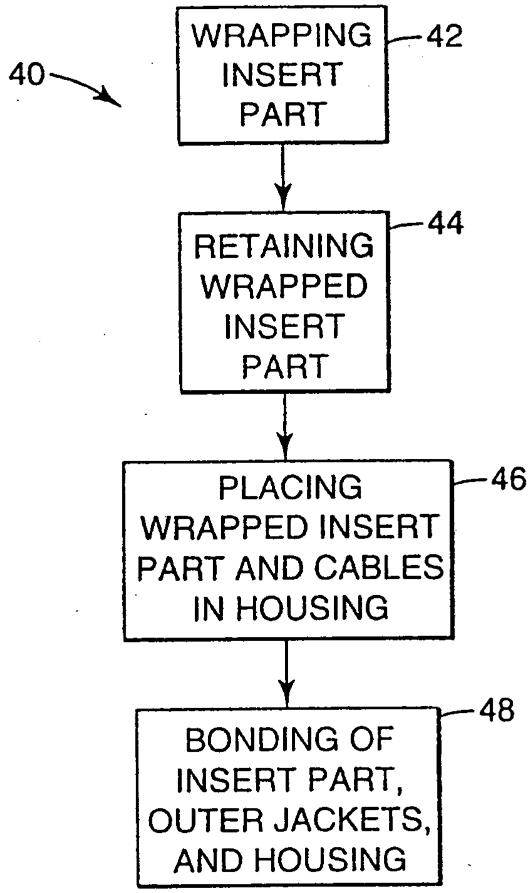

40
WRAPPING INSERT PART
42
RETAINING WRAPPED INSERT PART
44
PLACING WRAPPED INSERT PART AND CABLES IN HOUSING
46
BONDING OF INSERT PART, OUTER JACKETS, AND HOUSING
48

Fig. 3

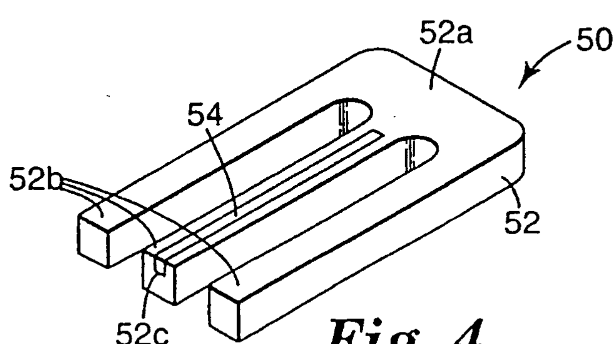
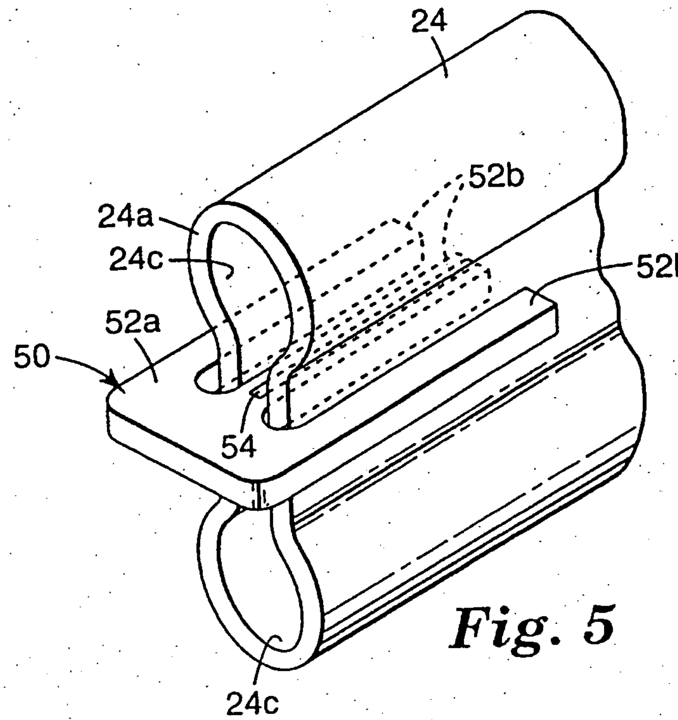

52a
50
54
52b
52
52c

Fig. 4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52b
24a
24c
52b
52a
50
54
24c

Fig. 5

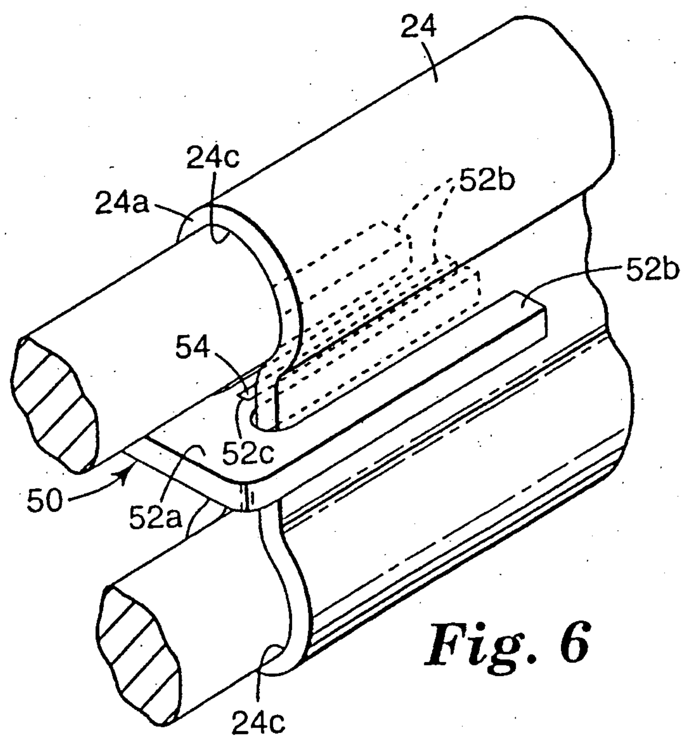
24
24c
52b
24a
52b
54
52c
50
52a
24c

Fig. 6

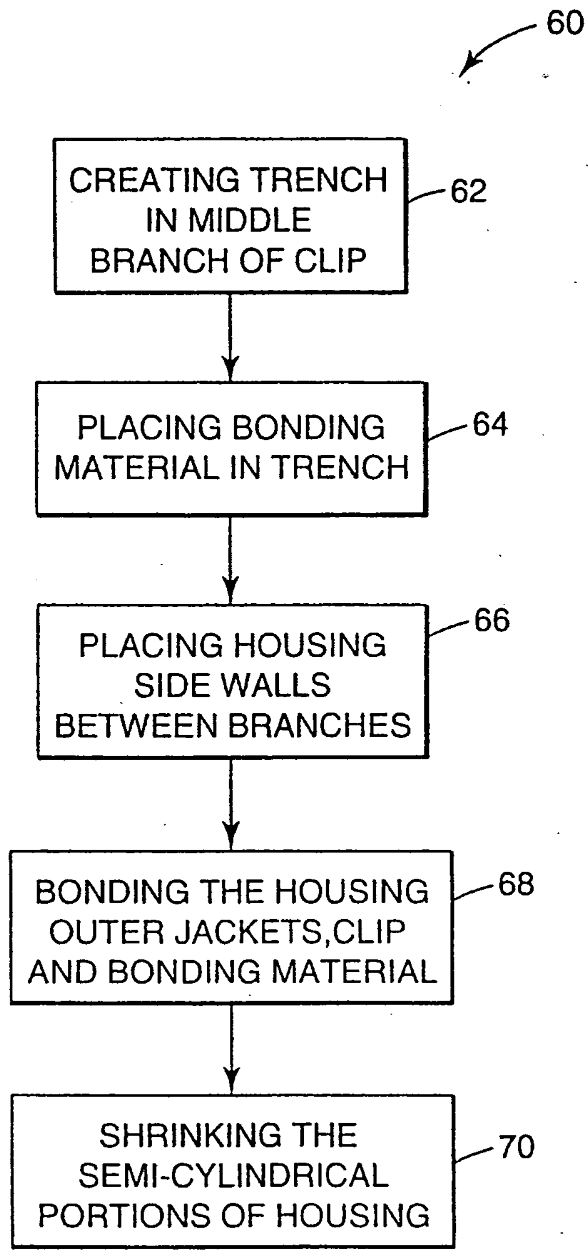
60
CREATING TRENCH IN MIDDLE BRANCH OF CLIP
62
PLACING BONDING MATERIAL IN TRENCH
64
PLACING HOUSING SIDE WALLS BETWEEN BRANCHES
66
BONDING THE HOUSING OUTER JACKETS,CLIP AND BONDING MATERIAL
68
SHRINKING THE SEMI-CYLINDRICAL PORTIONS OF HOUSING
70

Fig. 7

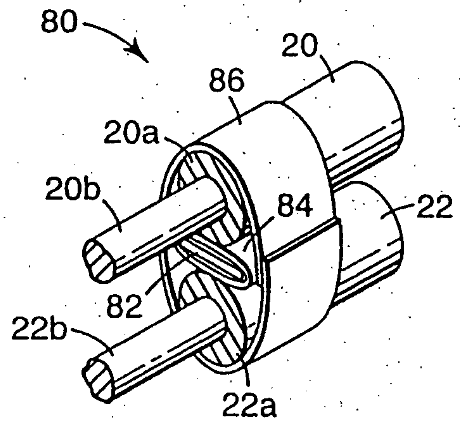

Fig. 8

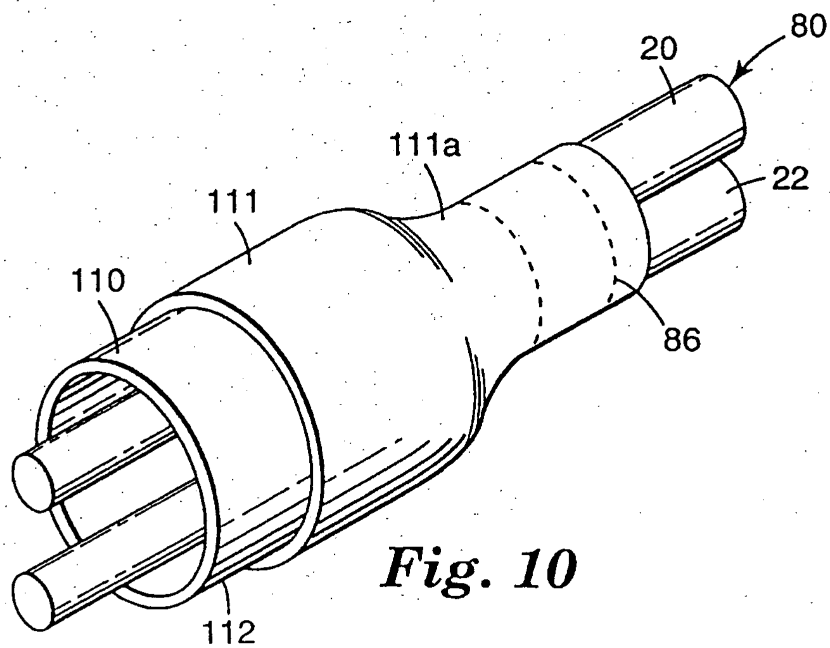

Fig. 10

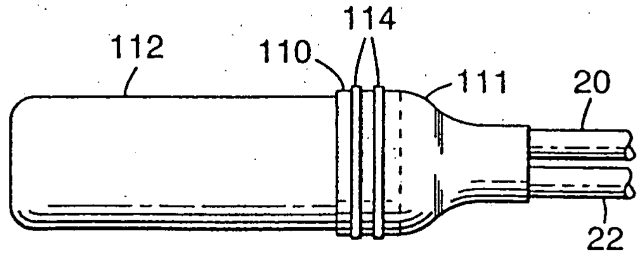

Fig. 11

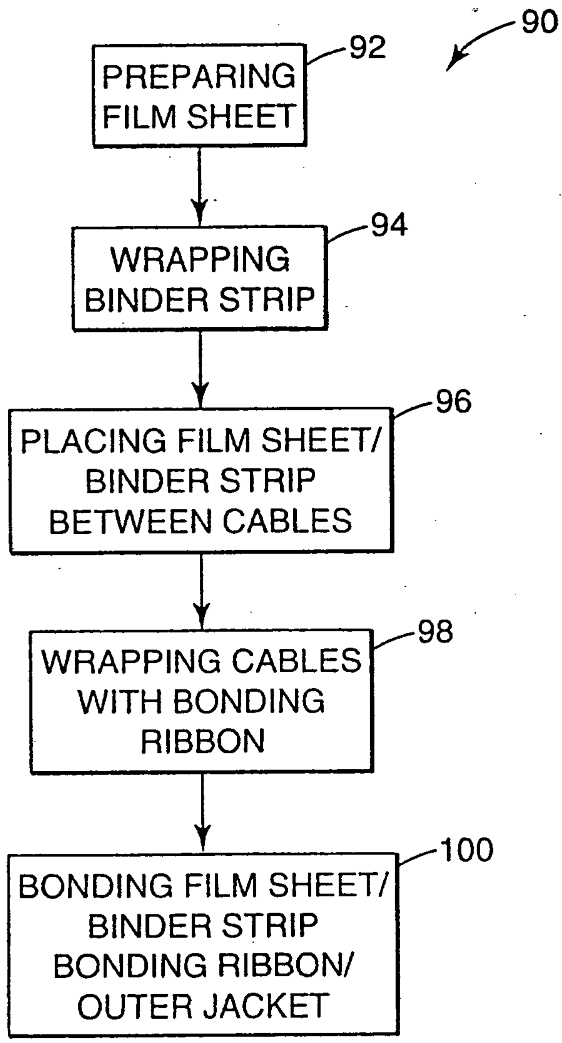
90
PREPARING FILM SHEET
92
WRAPPING BINDER STRIP
94
PLACING FILM SHEET/ BINDER STRIP BETWEEN CABLES
96
WRAPPING CABLES WITH BONDING RIBBON
98
BONDING FILM SHEET/ BINDER STRIP BONDING RIBBON/ OUTER JACKET
100

Fig. 9

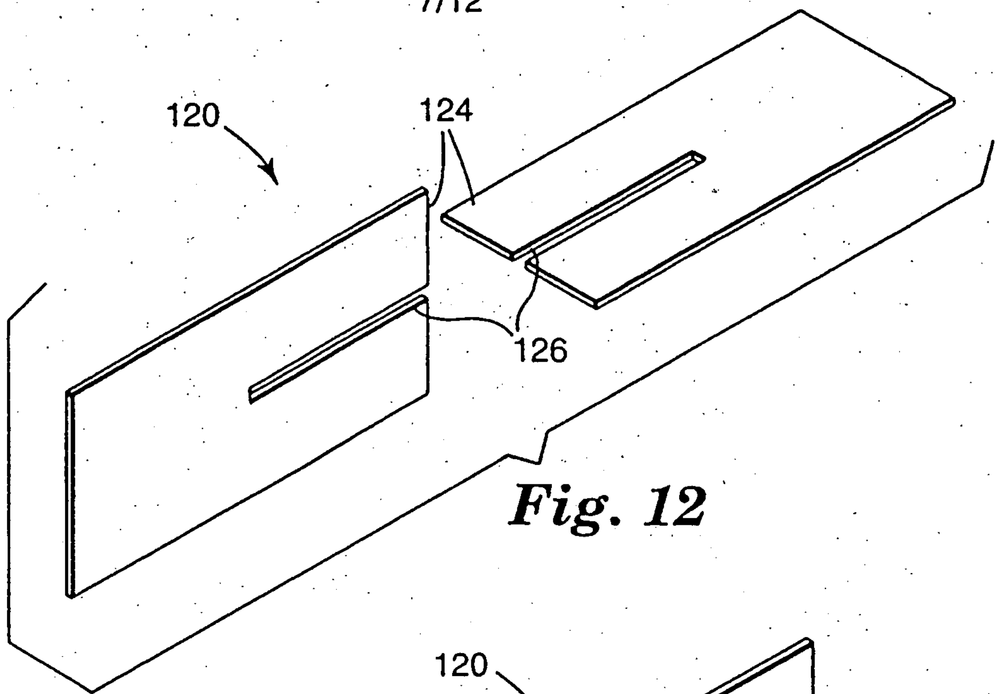

Fig. 12

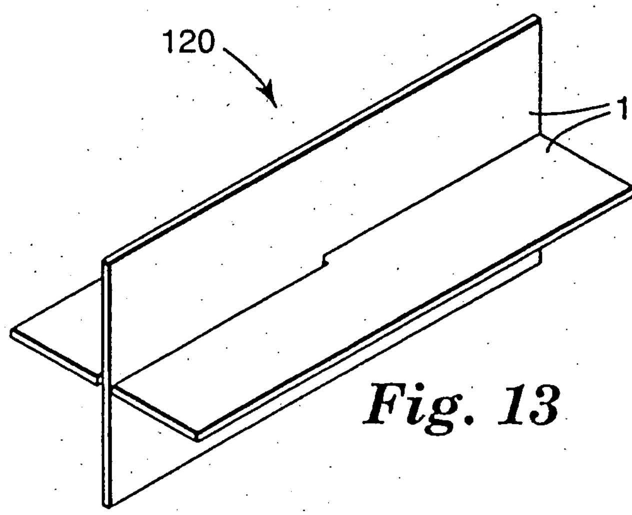

Fig. 13

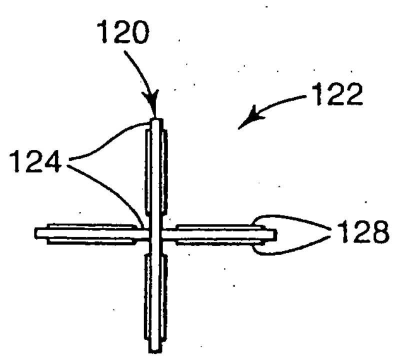

Fig. 14

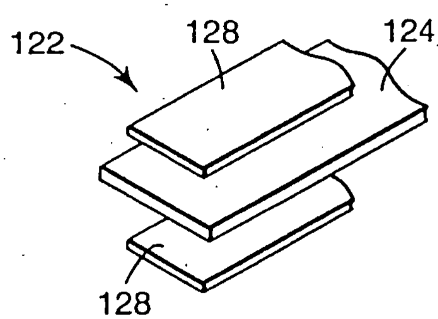

Fig. 15

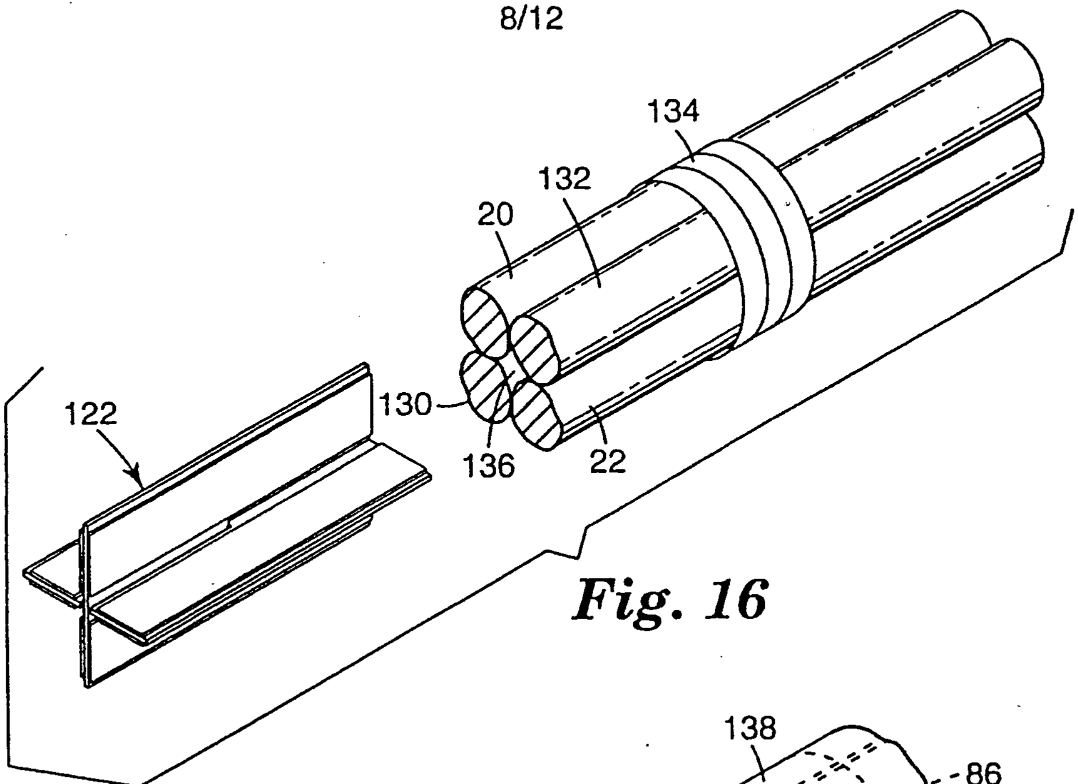

Fig. 16

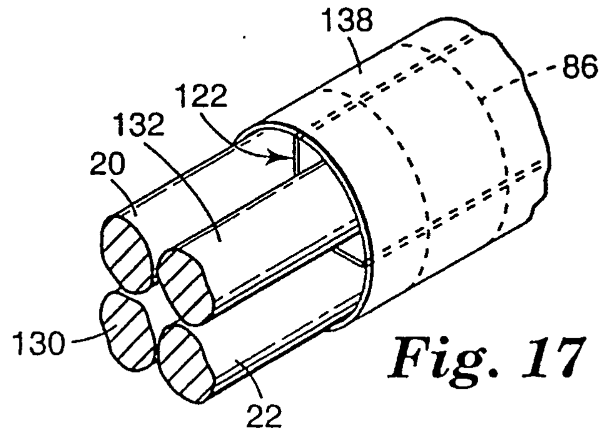

Fig. 17

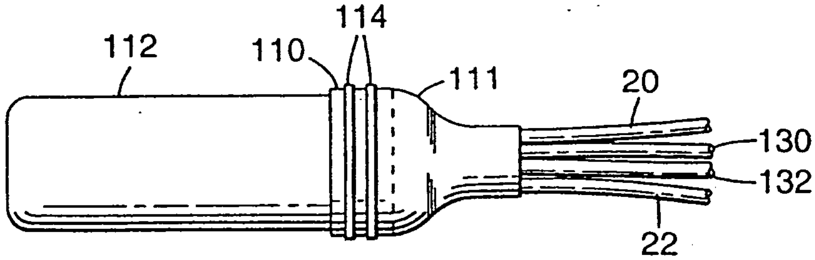

Fig. 19

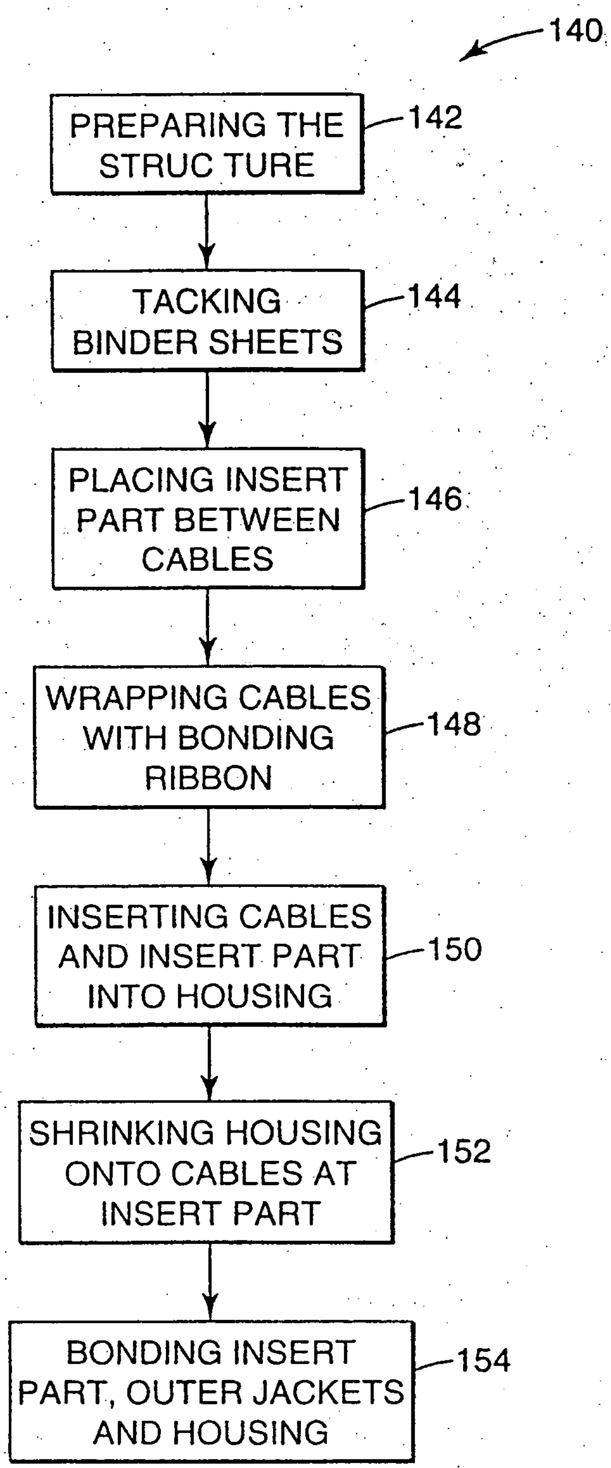
140
PREPARING THE STRUC TURE
142
TACKING BINDER SHEETS
144
PLACING INSERT PART BETWEEN CABLES
146
WRAPPING CABLES WITH BONDING RIBBON
148
INSERTING CABLES AND INSERT PART INTO HOUSING
150
SHRINKING HOUSING ONTO CABLES AT INSERT PART
152
BONDING INSERT PART, OUTER JACKETS AND HOUSING
154

Fig. 18

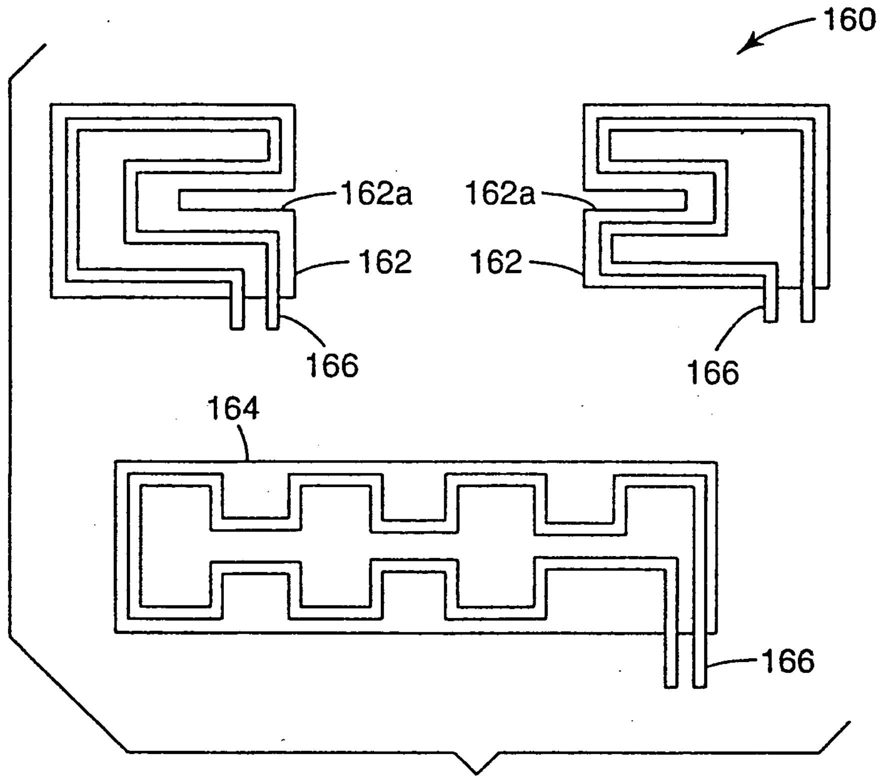

Fig. 20

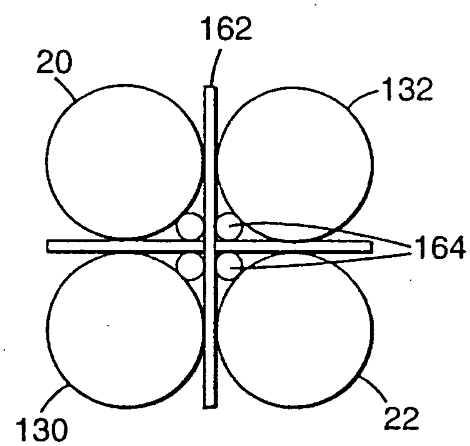

Fig. 21

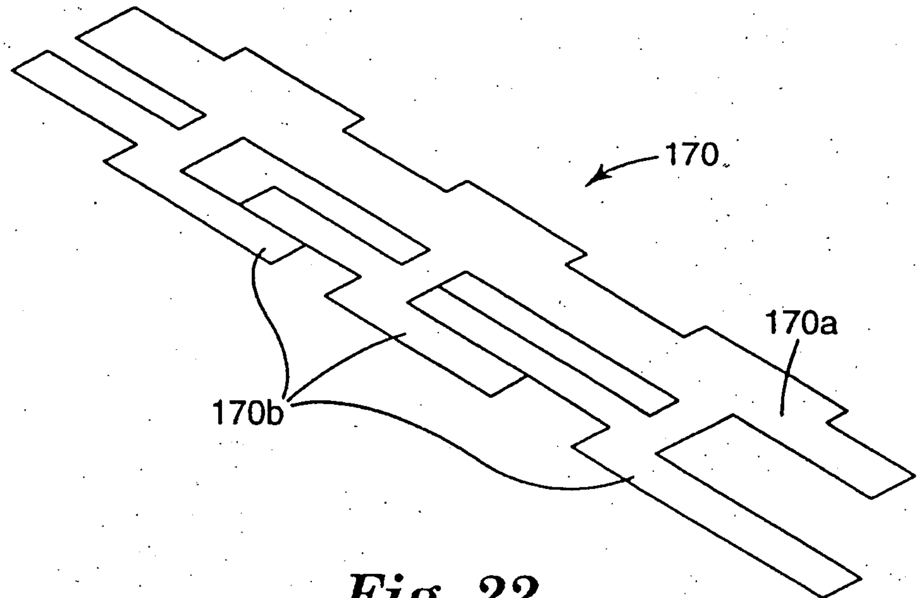

Fig. 22

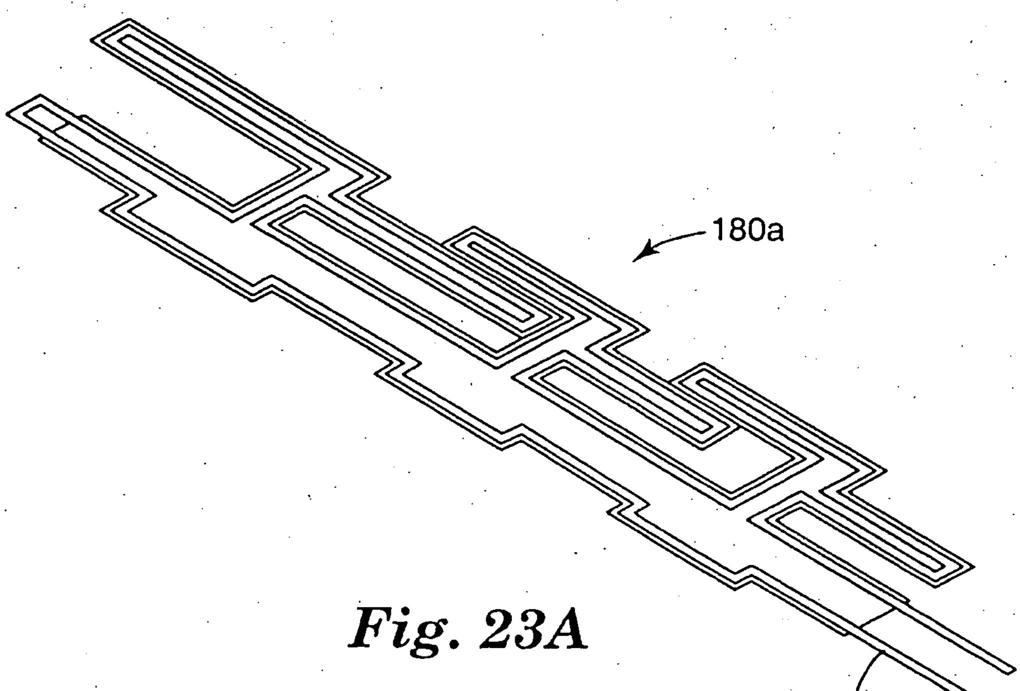

Fig. 23A

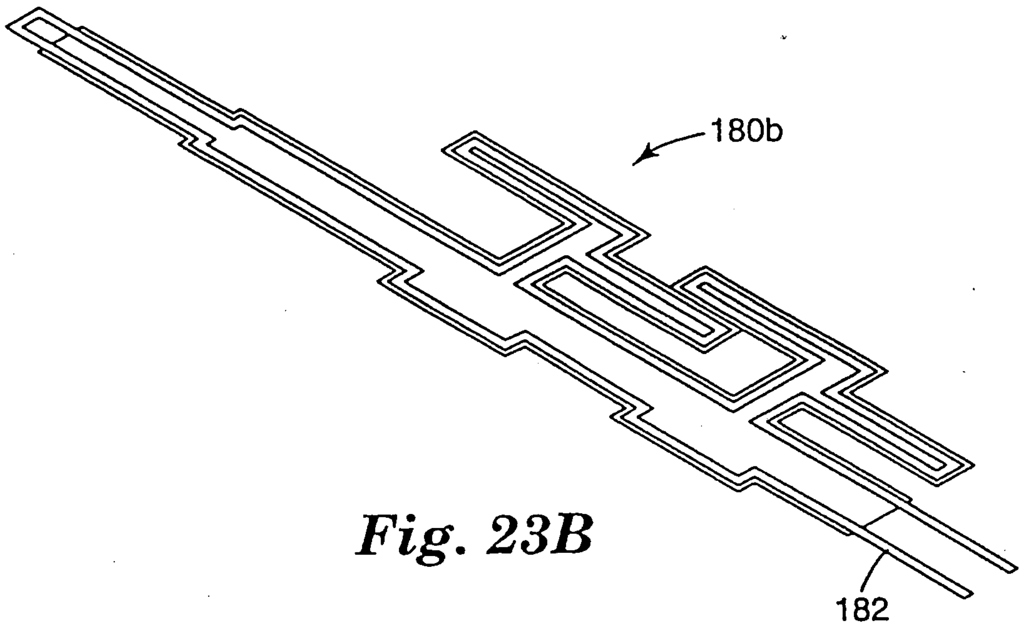

Fig. 23B

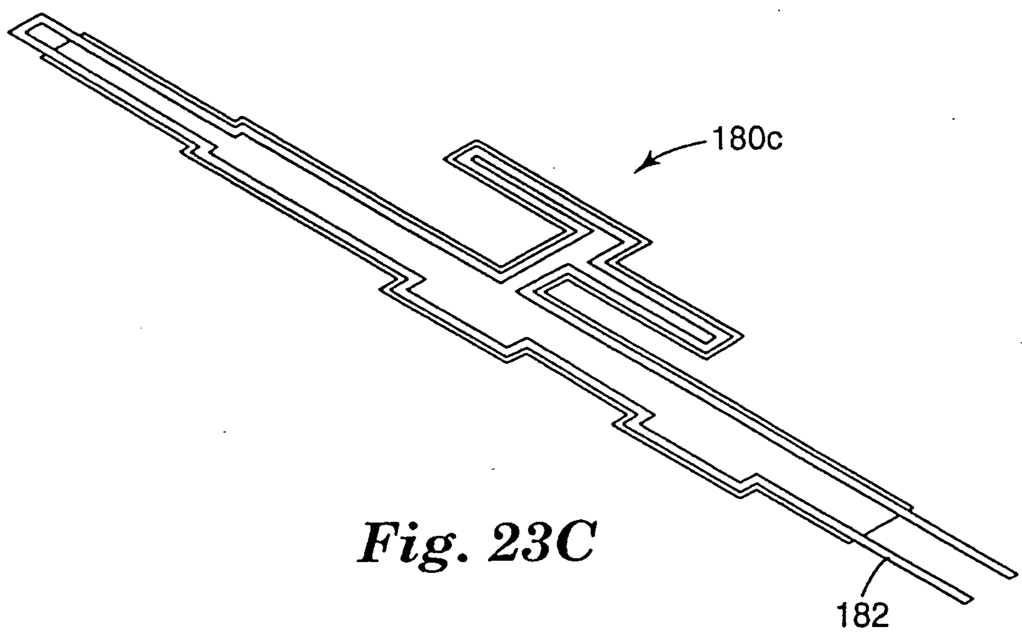

Fig. 23C

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 97/03441

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H02G15/013 H02G15/18

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H02G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 93 10960 A (MINNESOTA MINING AND MANUFACTURING COMPANY) 10 June 1993 see page 3, line 2 - line 32 see page 4, line 10 - page 7, line 14; claims 1-13; figures 1-4 ---	1-4,6-11
A	WO 90 06010 A (BOWTHORPE-HELLERMANN) 31 May 1990 see abstract; claims 1-5; figures 1-3,7 ---	1,48,54
A	EP 0 151 512 A (RAYCHEM) 14 August 1985 see page 1, line 1 - page 6, line 18 see page 18, line 11 - page 21, line 2 --- -/--	1,12,13, 48

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

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1

Date of the actual completion of the international search	Date of mailing of the international search report
17 July 1997	01.08.97
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer Lommel, A

INTERNATIONAL SEARCH REPORT

Inte   nal Application No
PCI/US 97/03441

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	WO 96 31090 A (MINNESOTA MINING AND MANUFACTURING COMPANY) 3 October 1996 cited in the application see abstract see page 3, line 2 - line 22; figures 1-4 -----	1,6

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 97/03441

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